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A SIMPLE, INEXPENSIVE DEGREE-HOUR COUNTER

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WBASO, Quincy, Florida

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INTRODUCTION

Degree-hours are defined as hours during which the ambient temperature departs from some specified standard. Degree hours are frequently of interest in science and industry. Horticulturists are especially interested in the accumulated hours when the temperatures are below defined base temperatures, generally referred to as, "dormancy hours" or "chill hours" (3, 4). Entomologists are interested in the number of hours above certain temperatures as indicators of the time of insect emergence (5). Plant pathologists may estimate the time of disease outbreak on the basis of an accumulation of hours when temperatures are above certain levels (1). The accumulated number of hours above 32 degrees in the spring may be of prime concern to hydrologists as an indicator of snow melt and the possibility of flooding (2).

Thermographs and hygrothermographs have been the principal instruments used to collect the degree-hour information. Tabulation of degree-hours from the charts of these instruments is time consuming, tedious, and subject to errors, since the data must be removed from small scale charts. Failure of pens to mark frequently results in missing information.

This paper describes a simple, accurate, inexpensive degree-hour counter which can be read directly without the necessity of removing data from charts (fig. 1).

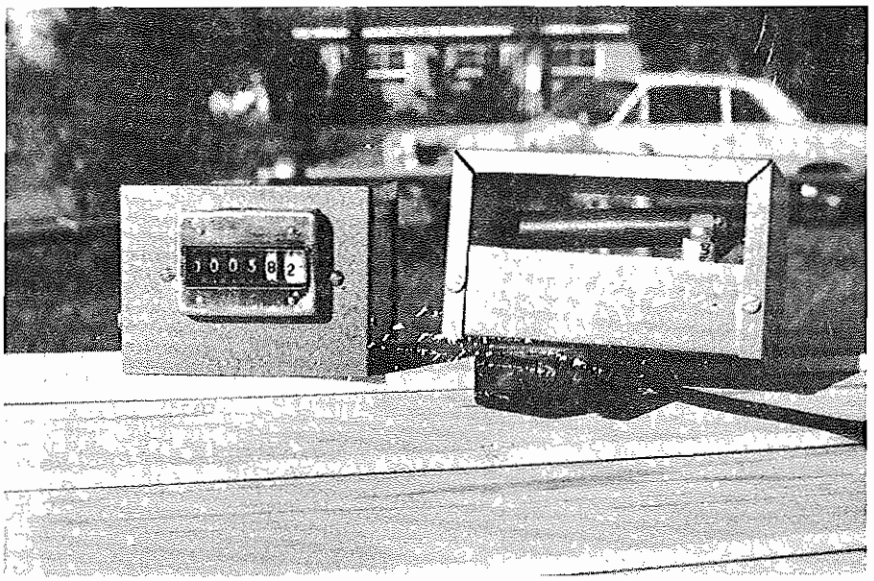

Figure 1 - Degree-Hour Counter

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DESCRIPTION OF DEGREE-HOUR COUNTER

The basic instrument to count degree-hours consists of two primary components, an hour counter or time totalizer and a thermostatic switch. Figure 2 shows a type of time totalizer which is available from many radio parts houses. This time meter is a digital readout type, calibrated in hours, tenths and hundredths, and will count up to 9999.99 hours. The counter shown in figure 2 is for A. C. current, however, counters for D. C. current are also available.

The second basic component for the degree-hour counter is an accurate thermostatic switch or thermoregulator control. It must be one that is readily adjustable, rugged and with a high degree of sensitivity. Two types of contacts are available in thermostatic switch controls. One closes or makes contact as the temperature decreases and is normally used in heating apparatus. This is the switch used in the degree-hour counter where the interest is in the accumulated hours when ambient temperatures are below some specified level. Thermo-switches that close as the temperature rises, normally used in cooling equipment, are readily available also. These are used in the degree-hour counter where the interest is in the hours above some specified level.

The thermostatic switch is wired in series with the counter so that the clock motor of the time counter is energized only when contact is made in the switch (see figures 3 and 4). The clock motor generates a very small amount of heat when it is running, therefore, the thermostatic switch should be remoted from the counter so that it will not be affected by the heat from the clock.

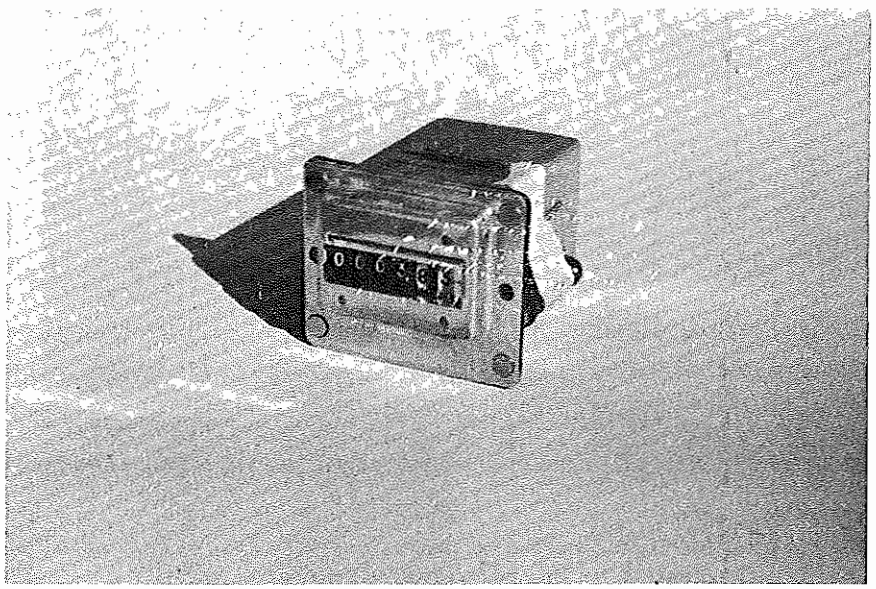

Figure 2 - Time Totalizer

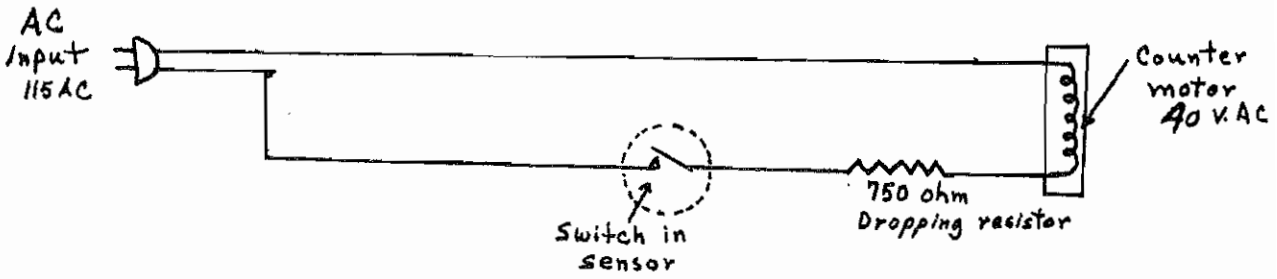

Figure 3. General schematic of degree-hour counter

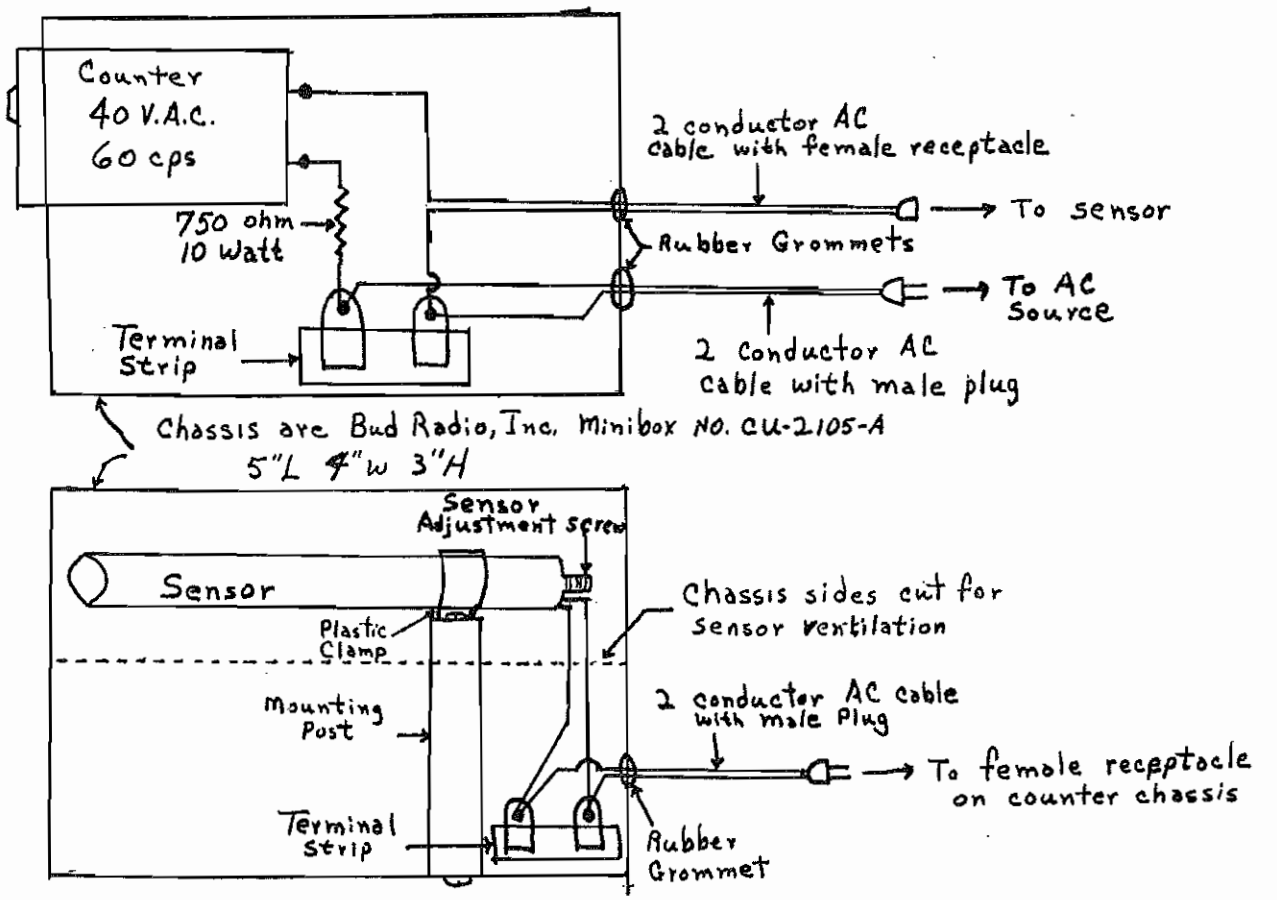

Figure 4. Schematic of degree-hour counter shown in figure 1

Figure 5 shows a Fenwal Thermoswitch[2] control which has been used successfully by the author. This electric switch is adjustable for a temperature range from -100 to 400° F. It has a sensitivity of ± 0.1° F., a rating of 10 amperes on 115 volts, A. C. For D. C. counters, a condenser with a capacity of 0.25 mfd. is required. The brass stem is 5/8 inch in diameter, 3 3/4 in. long, fitted with adjusting sleeve and 8-inch lead wires. The temperature setting can be changed by turning the adjusting sleeve the amount desired. One complete revolution changes the setting approximately 80° F.

The thermostat switch, which will hereafter be referred to as the sensor, may be remoted almost any distance from the counter. The electrical wire connecting the two components may be small since the current required for the counter motor is very small. It will, however, be necessary that the wire have a water proof covering. The sensor must be placed so that it will be exposed to the ambient temperatures of interest. It must be shielded from the rays of the sun, either by placing it in a regular weather shelter or by mounting it in a special shielding. Likewise, it should be protected from hydrometers so that it will not be affected by evaporative cooling. The sensor may also be weatherproofed and can be mounted below the soil surface, in case of interest in degree-hours in the soil.

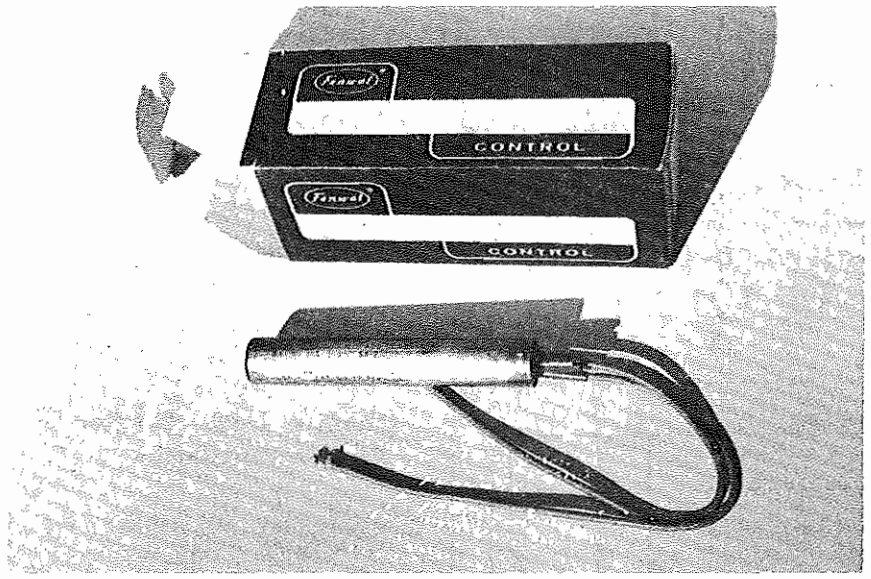

Figure 5 - Thermostat Control

[2]Mention of trade name and/or manufacturer is for identification only and does not imply endorsement by the Weather Bureau, the Envionmental Science Services Administration, or by the Department of Commerce.

Calibration of the sensor is accomplished by placing the end of the sensor in a container of water which has been brought to the base temperature, either by heating or cooling. After having been in the water for a period sufficiently long for temperature equilibration, the adjusting mechanism is turned until contact is made. The calibration should then be checked by alternately heating or cooling the water to make sure the sensor is making contact exactly on the base temperature. Slight adjustments may be necessary.

The counter may be mounted in several ways. Figure 6 shows the counter and sensor as mounted in the instrument shelter of the microweather station at the Agricultural Service Office, Quincy, Florida. Here the counter and the sensor are housed in small aluminum boxes which are inexpensive and also available at most radio supply companies. To make for versality in the use of the degree-hour counter, a coupling plug may be placed in the line between the counter and the sensor. This permits the interchange of sensors allowing the counter to be used at one time to count degree-hours above some specified temperature and at other times to count degree-hours below a specified temperature.

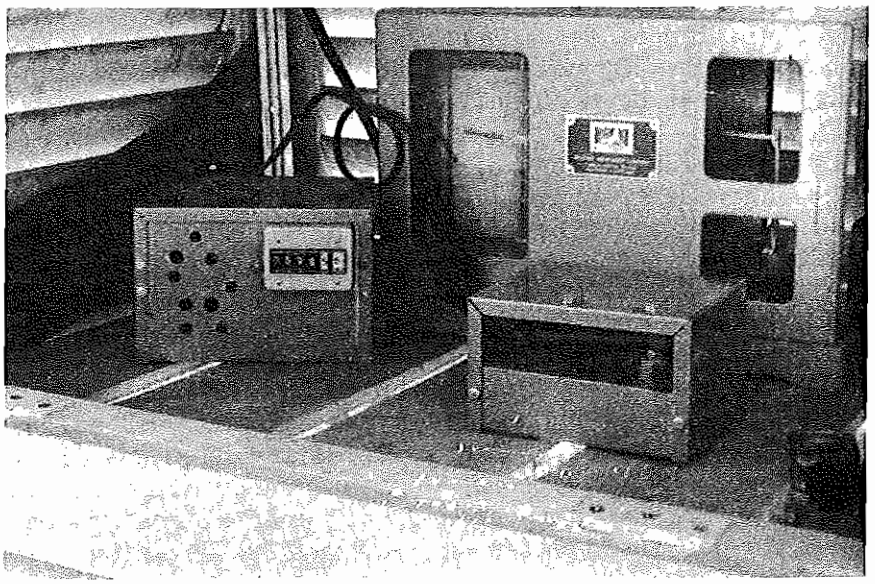

Figure 6 - Degree-Hour Counter being used to record "chill hours" WBASO, Quincy

The total cost of material for assembling the degree-hour counter as shown in Figure 6 was approximately $23, a fraction of the cost of a thermograph or a hygrothermograph. It has many advantages in addition to the lower cost. Other than the initial calibration, the degree-hour counter should operate with little or no maintenance. It can be read daily, weekly, monthly, or at the end of the season. The sensor should not change calibration if it is mounted so that the adjustment mechanism cannot be accidentally moved. The response time of a good sensor is much faster than that of the bimetalic strip of a thermograph thereby contributing to greater accuracy.

In some cases the interest may be in degree-hours between two base temperatures. The degree-hour counter can be readily adapted for this situation by using two sensors. One sensor should be the type that makes contact with temperature rise, while the other should make contact when the temperature decreases. The sensors will be set on the low and high base temperatures, respectively. With the two sensors wired in series with the counter, it will register only time when the temperature is between the specified base levels.

PRACTICAL APPLICATIONS

Horticulturists, working with deciduous nuts and fruits, are interested in bi-weekly accumulation of degree-hours below 55°F., and 45° F., and degree-hours above 65° F. By using three of the degree-hour counters only one observation will be necessary each 2 weeks.

Hydrologists and river forecasters can use the degree-hour counters with a base of 32 degrees to indicate the extent of snow melt and flood potential. Fuel oil companies could set the device on a base of 65° F., to indicate the needs of customers. Entomologists, aerial spray companies and agricultural chemical interests could use the degree-hour counter to forecast insect emergence and increases in insect populations and the scheduling of spray programs. Plant growers are interested in degree hours of the soil and could use the counter to estimate the date transplants will be ready for shipment. Crop maturity has already been associated with degree-hour data and the counter could serve an expanded use in this area. With the sensor placed in the soil the degree counter could be successfully used to indicate planting dates to secure good crop stands and early growth. Climatologists could use the counter in many ways in defining climates.

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